



The
Patent
Office

PCT/GB 89 / 03 496

27 OCTOBER 1999

INVESTOR IN PEOPLE

09/830387

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

EJU

REC'D 23 NOV 1999

WIPO PCT

GB 99/3496

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

PRIORITY

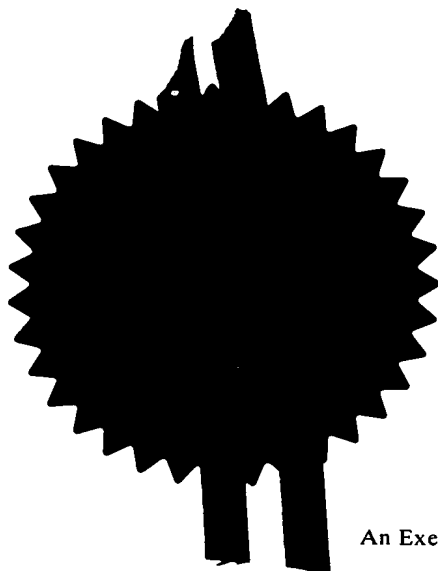
DOCUMENT

SUBMITTED OR TRANSMITTED IN
COMPLIANCE WITH RULE 17.1(a) OR (b)

Signed

Dated

28 NOV 1999



THIS PAGE BLANK (USPTO)

THE PATENT OFFICE

A

27 OCT 1998

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference

98P4851/F21518/GB/R76/DA/rh

2. Patent applicant
(The Patent Office)

9823396.8

27 OCT 1998

3. Full name, address and postcode of the or of each applicant (*underline all surnames*)

ROKE MANOR RESEARCH LIMITED
ROKE MANOR
OLD SALISBURY LANE
ROMSEY
HANTS SO51 0ZN

Patents ADP number (*if you know it*)

If the applicant is a corporate body, give the country/state of its incorporation

UNITED KINGDOM

561 5455005

4. Title of the invention

METHOD OF AND APPARATUS FOR POWER CONTROL

5. Name of your agent (*if you have one*)

DEREK ALLEN

"Address for service" in the United Kingdom to which all correspondence should be sent (*including the postcode*)

SIEMENS GROUP SERVICES LIMITED
INTELLECTUAL PROPERTY DEPARTMENT
SIEMENS HOUSE, OLDBURY
BRACKNELL, BERKSHIRE RG12 8FZ

Patents ADP number (*if you know it*)

02898443005

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (*if you know it*) the or each application number

Country

Priority application number
(*if you know it*)

Date of filing
(*day / month / year*)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing
(*day / month / year*)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (*Answer 'Yes' if:*

YES

- a) any applicant named in part 3 is not an inventor, or
 - b) there is an inventor who is not named as an applicant, or
 - c) any named applicant is a corporate body.
- See note (d))

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form

Description 5

Claim(s) -

Abstract -

Drawing(s) -

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (*Patents Form 7/77*)

Request for preliminary examination and search (*Patents Form 9/77*)

Request for substantive examination (*Patents Form 10/77*)

Any other documents
(please specify)

11.

I/We request the grant of a patent on the basis of this application.

Signature

Date 26.10.98

D ALLEN (Their Attorney)

12. Name and daytime telephone number of person to contact in the United Kingdom

D ALLEN - 01344 396808

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- For details of the fee and ways to pay please contact the Patent Office.

METHOD OF AND APPARATUS FOR POWER CONTROL

The present invention relates to a method of and apparatus for power control, of the type used in a communication system, for example, in a spread-spectrum communication system, such as a Code Division Multiple Access (CDMA) communication system.

In a CDMA cellular communication system, power control is used to equalise signal to noise (S/N) ratios of the signals received at a base station from various mobile terminals. In the term 'signal to noise ratio', the term 'noise' is intended to include interference in the form of signals from other mobile terminals, as well as background noise.

A known technique involves measuring the S/N ratio in respect of signals received from a given mobile terminal over a measurement interval and comparing the measured S/N ratio against a desired threshold. If the measured S/N ratio exceeds the desired threshold, a binary 1 (or 0, depending upon the convention employed) is transmitted (within the plurality of signals transmitted from the base station) to the mobile terminal originating the given signal. If the measured S/N ratio is lower than the desired threshold, a binary 0 (or 1, depending upon the convention employed) is transmitted to the given mobile terminal. The mobile terminal, in turn, responds by reducing its transmission power by, for example, 1 dB if a 1 (or 0) is received or by increasing its power by 1 dB if a 0 (or 1) is received. In this way, the received signal to noise ratio is held approximately constant as path loss between the given mobile station and the base station varies and/or as the level of interference at the base station from other mobile terminals varies.

The above technique is effective in the transmission of continuous data where any transients associated with the initial setting of transmitter power at the mobile terminal can be ignored. However, where individual bursts (frames) of data are transmitted, for example packet data, the mobile terminal must set its initial transmitter power according to a so-called open loop power control technique. In this technique, the base station signals to the mobile terminal(s) the power at which the base station is transmitting; this can be either the total power received or the power of a particular signal which the mobile(s) station is receiving, and the interference level at the base station. The mobile terminal measures the power level of the corresponding signal received from the base station and uses the signalled information, i.e. the information relating to signal strength at the base station, to determine the power at which the mobile terminal must transmit in order to produce a required signal to noise ratio at the base station. On average, this should be the correct power. However, in many CDMA systems the frequency used for transmission from the base station to the mobile terminal (down-link) is different from the frequency used for transmission from the mobile terminal to the base station (up-link). Such a scheme is known as a Frequency Division Duplex (FDD) scheme. In an FDD scheme, propagation of signals is non-reciprocal in the short term, for example, multi-path fading on the down-link is uncorrelated with multi-path fading on the up-link. This effect can be mitigated somewhat by averaging the power measurements at the mobile terminal over the likely fading period. However, this does not cater for the instantaneous path level fluctuations in the up-link direction, resulting in the power transmitted by the mobile terminal being too high or too low at the start of the frame.

In a typical CDMA system, forward error correction (FEC) with interleaving is employed in order to mitigate the effects of fading and interference from other signals operating on the same frequency. If a known soft decision

decoding technique is employed, the effect of the interleaving is to make the probability of uncorrectable errors in an interleaved frame a function more of the average S/N ratio over the frame rather than, for example, the worst case S/N ratio. Consequently, if the S/N ratio at the start of a frame is too high, implementation of power control reduces the S/N ratio to the required threshold by the end of the frame, but the overall average will be higher than necessary. Conversely, if the S/N ratio at the start of a frame is too low, implementation of power control increases the S/N ratio to the required threshold by the end of the frame, but the overall average will be lower than necessary.

It is therefore an object of the present invention to obviate or at least mitigate the above described disadvantages.

According to the present invention, there is provided a method of power control in a communications system capable of transmitting a frame having a plurality of time intervals, the method comprising the steps of : selecting a time interval in respect of which a power level is to be determined; summing any previously measured power levels in respect of any time intervals preceding the selected time interval; determining the number of any remaining time intervals, and setting the power level in respect of the selected time interval based upon the sum of previously measured power levels and the number of remaining intervals in order to achieve a predetermined signal to noise ratio in respect of the frame.

Preferably, the power level is set during transmission of the frame in such a way as to tend to keep the received signal to noise averaged over the frame constant. This differs from known techniques which try to modify the power level within each time interval so as to substantially keep to the predetermined signal to noise ratio during each interval.

Preferably, the time interval is a time slot.

At least one embodiment of the invention will now be described by way of example.

A CDMA system comprises at least one base station arranged to communicate with a mobile terminal over a radio-frequency (RF) interface by transmitting a frame of data. The frame is transmitted from the mobile terminal to the base station, during which there are N adjustments of power corresponding to N time slots in the frame. For the first adjustment in the frame, a power threshold is set so as to be substantially equal to the required average S/N ratio at the base station. For the next and each of the subsequent adjustment, the power measurements made preceding the next and each subsequent adjustment are summed and the S/N ratio is determined based upon the assumption that if the determined S/N ratio is maintained throughout the remainder of the frame, the target for the average S/N ratio will be met.

For a power control interval range from 0 to $N-1$, the above technique can be expressed mathematically as follows.

Suppose we are about to set the power threshold for the j indexed slot. At a j th interval, the sum of power received at the base station during previous intervals can be generally expressed as: $\sum_{i=0}^{j-1} \gamma_i$, where the S/N ratio received in the i th interval is γ_i ; the desired total S/N ratio sum over the frame is then $N\gamma_d$, where γ_d is the required S/N ratio.

$N-j$ power control intervals therefore remain in the frame for which a power level is predicted. In order to satisfy the S/N ratio requirement over the entire frame, the predicted signal to noise ratios for the remaining intervals, γ_p needs to satisfy the following equation:

$$\sum_{i=0}^{j-1} \gamma_i + (N-j)\gamma_p = N\gamma_d$$

Thus, we can solve the above equation for γ_p to find the predicted required power level (and therefore the next threshold):

$$\gamma_p = \frac{N\gamma_d - \sum_{i=0}^{j-1} \gamma_i}{N-j}$$

Minor obvious modifications can be made within the normal ability of a skilled person to take account of non zero periods for measurement and for signalling within the power control sub-system.

If the S/N ratio received is higher than necessary at the beginning of a frame, then it will ideally be received at a level lower than the nominal S/N ratio by the end of the frame. Where multi-path fading occurs, none of the targets will be exactly met, but the use of this invention will result in smaller variation in average power over the frame, leading to an improvement in system capacity.

THIS PAGE BLANK (USPTO)

THIS PAGE BLANK (USPTO)

DET 9B99/03496

SIEMENS

271099

MA
THIS PAGE BLANK (USPTO)